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COATING OF SLATE WITH POWDER POLYESTER PAINTS

The production technology of protective decorative coatings for asbestos-cement boards carried out with the use of powder polyester paints of domestic manufacture is described. The technology was implemented in productive conditions of the Open Joint Stock Company “Krichevcementnoshifer”. The results of testing of asbestos-cement boards with polymeric coatings of blue, green and dark-red colours are presented. The testing was carried out for adhesion, frost- and heat-resistance, abrasive resistance, resistance to variable temperatures, accelerated weathering, water-resistance, colour fastness. It is shown that the complex of performance characteristics of the pilot lot of asbestos-cement boards with polymeric coatings corresponds to the requirements of STB 1118-98.

Key words: polyester powder paint, asbestos-cement slate, climatic resistance.

Introduction. Among the many modern roofing slate retains significant exposure latitude of application due to its durability and relatively low cost. To attract new customers is necessary to continuously improve its properties, so it is now becoming more widespread to get a colored slate.

The powder polymer paint (PC) is widely used as a modern-tech product for creating high-quality and durable coatings [1–3]. The advantages of powder coatings over liquid paints [1, 2] allowed the powder coating technology to be widely spread in the industry, and it enabled powder coatings to win a place on the market of paints and varnishes.

The technological process of painting with powder paints products consists of the following stages:

– the surface preparation (removal of dirt, dust removal, priming, pre-drying to reduce moisture slate);

– the application of the powder paint layer on the surface to be painted;

– formation of coating film: fusing, curing, cooling.

Surface preparation is the initial stage of PC coloring process. It largely determines its durability. When applied to a PC on a poorly prepared surface (dust, the presence of foreign matter), a rapid peeling of the PC is used in small areas, and over the entire surface. This step is particularly important for the surface of the slate, which should be thoroughly cleaned from dust and brushes hardened cement pieces. Then the surface is treated with a primer or impregnation. Primer it is applied to the surface of the first layer, it penetrates deep into the substrate (microcracks in), it is reinforced to improve adhesion to subsequent layers. In addition, to protect the surface of slate from dampness and mold. To possess binding and reinforcing properties it is necessary to prevent damage of the basic surface, and to block the action of alkali salts, which causes salting-out and increases adhesion [4, 5].

Drains and primers are used for protection against water, they penetrate deep into the pores during drying do not form a surface crust, do not prevent the evaporation of moisture from the material, retain the color and texture of the surface, have a high chemical resistance, weather resistance, harmless. Most of the listed properties match silicones.

Humidity of asbestos slate sheets is 11–12%. Such asbestos slate humidity leads to defects in the formation of the PC. Therefore, the forced removal of water is required. Drying plants (furnace) is the most common type of equipment for drying products.

To dry the surface of slate, asbestos cement sheets should be kept for 1 hour at 170°C.

The painting chamber slate must be cooled before sending. This is important because the optimum temperature is below 38°C. Cooling is performed at ambient temperature.

Powder coatings are applied on the workpiece by electrostatic spraying or by dipping them into the fluidized bed (electrification with or without particles) or flame spraying method [6, 7].

Electrostatic spraying is most convenient and ensures better control of the coating thickness. It has become the main method of coating in the industry. In the powder spraying installation located in a special hopper (feeder) is fluidized with compressed air. The ejector collects the powder from the hopper and transports it to the spray gun. The controller is used to control the powder feed and air, as well as to maintain the spraying parameters. The powder sprayer is reported with electric charge by ion bombardment in an electric field (corona charging method) or by friction (tribostatic charging method).

Main part. Experimental batch of sheets of asbestos-cement slate with a polymer coating has been released in production conditions PRUE “Krichevcementnoshifer”.

Surface preparation asbestos-cement slate substrates was performed as follows: de-dusting, purified from all contamination, and primer compositions were applied to slate samples:

– Silicone (sample No. 1);

– Organic-containing silicone additive (sample No. 2);

– Silane emulsion (sample No. 3);
– On the basis of polyester resin (sample No. 4);
– Based on epoxy and polyester resin (hybrid) (sample No. 5).

The samples treated with liquid compositions (samples No. 1, 2, 3), one-sided two-layer coating were applied. In the case of powder primers (sample No. 4, 5) the paint applied in a single layer electrostatic method, observing the required curing time.

For the polymer coating on the asbestos-cement corrugated sheets used polyester powder paint:

1) low-temperature powder paint (blue color) with the curing temperature of 140°C;

2) high-temperature powder coating (green and maroon) with a curing temperature of 190°C [3, 8, 9].

The application of the powder paint was conducted at a normal temperature slate by electrostatic spraying. The slate sheets with a layer of powder paint directed into the passage with electric oven to form a coating layer comprising a fusion of the powder paint to form a film.

Curing of the powder paint at a temperature of 190°C for 25 min. When applying powder paint of low-temperature film formation is occurred at a temperature of 145°C for 20 min. The resulting coating was controlled surface appearance, physical, mechanical and performance parameters. The appearance was evaluated by visual inspection for the presence of bubbles, pores, craters, water stains and cracks.

The performance properties of the polymer coating was determined after 140 test cycles on the frost resistance to change bond strength (adhesion) of the polymer coating to the asbestos-cement slate and flexural strength before and after the test (Table 1). It was found that the adhesive strength of the polymer coatings with asbestos cement base on the samples subjected to tests for frost resistance, ranging from 2.5 to 3.2 MPa and satisfies the requirements of STB 1118-98 (change number 1).

Table 1

Sample test results Asbestos-cement slate coated on frost resistance (140 cycles)

Name	Bonding strength with the base, MPa		Flexural strength, MPa	
	to test	140 cycles	begore test	140 cycles
Low-temperature paint, color – blue	3.3	3.2	36.7	35.7
High-temperature paint, color – green bordeaux	2.9 2.7	2.8 2.5	34.4 33.6	33.9 32.8

The residual flexural strength of asbestos-cement sheets with polymer coating after 140 cycles on the frost resistance test is more than 90%, which satisfies the requirements of STB 1118-98 (change number 1). The nature of the destruction of preproduction is cohesive. After 140 test cycles to frost fracture behavior changes and becomes adhesive. It should be noted that, after 140 cycles of testing frost resistance changes in appearance (cracking, peeling, color change) is observed (Table 1).

Slate, like most building materials, has an alkaline nature, as it contains cement and lime. In this case the alkaline nature of the surface can affect the PC polymer. The choice offered by powder pigments for paints and varnishes (coatings) because of the high curing temperature is quite limited. You need to use more expensive pigments, which affects the price of the powder coatings for saturated colors. However, it should be noted that in the production of powder paints, in contrast to liquid, no tinting operation.

In this paper, the choice of colors into account the most popular roofing colors (blue, green, burgundy), is used in construction. To evaluate the color stability of colored polymer PCs asbestos-cement slate is controlled after the light emission factors (artificial aging): the color difference E is between the initial and irradiated samples; changes in adhesion strength (adhesion); abrasion resistance (Table 2).

Test of accelerated climatic aging PC polymer was carried out according to the following regime:

the temperature in a climatic chamber is +50°C;
relative humidity is 60%;
UV irradiation of 57.7 W/m^2 mode;
IR 730 W/m^2;
the visible range of 320 W/m^2.

Table 2

Features of polymer PC after accelerated climate aging

Name indicator	Significance
Coating colour fastness: – blue	Δa = 1.3947 Δb = 0.1919 ΔL = 0.1488 ΔE (Δa, Δb, ΔL) = 1.47
– green	Δa = 0.6635 Δb = 0.0944 ΔL = 0.2924 ΔE (Δa, Δb, ΔL) = 1.67
– bordeaux	Δa = 1.3947 Δb = 1.1232 ΔL =1.0947 ΔE (Δa, Δb, ΔL) = 1.64
Adhesion, MPa. Colour: – blue – green – bordeaux	 3.3 2.9 2.7
The strength of the polymer coating to abrasion	No violation of the integrity of the polymer coating

Table 3

Performance features asbestos-cement sheets with polymer PC

Indicator, specifications of characteristics	The value of indicators
1. Appearance (color coordinates and color uniformity ΔE (Δa, Δb, ΔL)). Colour: – blue – green – bordeaux	 1.6114; 1.5618; 1.7986; 1.5680 0.7167; 0.8312; 0.9014; 1.0094 0.8994; 1.0054; 0.9654; 0.2955
2. Coating thickness, mm	165–180
3. Adhesion of the polymer coating, MPa	3.2–3.6; cohesive fracture pattern on slate
4. Frost resistance of 140 cycles: – change in appearance – coating adhesion, MPa – flexural strength, MPa	The absence of traces of cracks and destruction 2.1–3.2; adhesive fracture pattern 32.9–36.8
5. Resistance to changing temperatures (from +60 to –40°C) after 10 test cycles to change the appearance	There are no changes in the appearance of the polymer coating
6. Strength color coating abrasion	No violation of the integrity of the polymer coating
7. Heat resistance of the polymer coating at 150°C for 2 hours	There are no changes in the appearance of the polymer coating
8. Colour fastness of the polymer coating after accelerated climatic aging for 168 hours Colour: – blue – green – bordeaux	 ΔE (Δa, Δb, ΔL) = 1.47 ΔE (Δa, Δb, ΔL) = 1.67 ΔE (Δa, Δb, ΔL) = 1.64
9. Resistance to static action of water for 24 hours, to change the appearance. Colour: – blue – green – bordeaux	 Changes in the appearance of the missing ΔE (Δa, Δb, ΔL) = 0.02 ΔE (Δa, Δb, ΔL) = 0.01 ΔE (Δa, Δb, ΔL) = 0.02

The total integrated flux of optical radiation from the simulation S1200 radiator at a distance of 60 cm from the radiation source was 1,107.7 W/m^2. The amount of energy of irradiation simulation emitter samples for 168 hours was 670 mJ/m^2. The test results are shown in Table 2.

Changes in the color of colored polymer PC asbestos sheets after accelerated climatic aging for 168 hours was observed. The maximum color difference of E color for PC polymer is from 1.47 to 1.67, which is below the allowable (it is not more than 3.0 on the STB 1118-98).

Tests for abrasion polymer slate PC asbestos samples showed that changes of its appearance are not observed. Also, there are no changes in the appearance of the PC polymer when tested for resistance to the effects of variable temperatures from +60 to –40°C after 10 test cycles. When tested for resistance to the static action of water discoloration PC does not take place, the color difference is 0.01–0.02. The results of evaluation of the performance properties of asbestos-cement sheets with polymer PC are shown in Table 3.

The polymeric coating of asbestos-cement sheets after accelerated climatic aging for 168 hours are color retention. The maximum change in color characteristics, uniformity of color for the green, blue and burgundy color is in the range of 1.47 to 1.67, which is below the permissible (less than 3.0 on the STB 1118-98).

Tests of abrasion polymer coating asbestos slate coated samples showed that in the control and the samples subjected to tests, changing the appearance of no polymer coating. Also, there are no changes in the appearance of the polymer coating when tested for resistance to the effects of variable temperatures from +60 to –40°C after 10 test cycles. Determination results of water absorption by capillary leak slate PC polymer samples are shown in Table 4.

The study also found that there is a decrease in the porosity of the capillary surface with the polymer samples slate PC as compared to the control sample without PC 8–10 times. Exposure to water has no any effect on the appearance of a PC polymer.

Table 4

Sample test results of asbestos-cement slate PC with a polymer water absorption during capillary leak

Sample	The water absorption in kg/m^2, per 24 h	The appearance changing
Low-temperature paint		
Sample No. 1	0.053	the appearance changing is absent
Sample No. 2	0.054	
Sample No. 3	0.055	
Sample No. 4	0.040	
Sample No. 5	0.0143	
High-temperature paint		
Sample No. 1	0.075	the appearance changing is absent
Sample No. 2	0.046	
Sample No. 3	0.10	
Sample No. 4	0.025	
Sample No. 5	0.072	
Control sample	0.97	–

Conclusion. The described process covers an asbestos slate sheets with polyester powder paint in a production environment PRUE "Krichevcementnoshifer".

Experimental batch of sheets of blue, green and burgundy colors were tested for compliance with the requirements of the lacquer coating of the class. After testing frost (140 cycles), polymer coatings essentially unchanged adhesion remains high at 2.5–3.2 MPa; residual flexural strength of more than 90%; discoloration, cracking, peeling was observed. With accelerated climatic aging (irradiation energy of 670 mJ/m), the impact of variable temperatures from +60 to –40°C (10 cycles) and water (24 h) changes in performance coatings below acceptable STB 1118-98 (change number 1). Coatings are resistant to the conditions of their contact with the alkaline surface of asbestos-cement slate. Water absorption under capillary leak coated slate 8–10 times lower than without a coating.

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